

TRACE ELEMENT DEFICIENCIES IN CAPE VEGETATION.

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(With Plates I to V.)

INTRODUCTION

Trace element deficiencies in plants have been studied extensively, and deficiency symptoms for many plants described¹; but virtually all studies have been made upon cultivated plants, and very little is known about the deficiencies of undisturbed natural vegetation. The fact that specially adapted floras develop in areas which are deficient in certain essential nutrients has been noted by such workers as Rademacher² who points out that the flora of the North German Plain is especially adapted to the low copper content of this region. Russian workers, such as Kovalski³, recognise the existence of "biogeochemical provinces", regions which are characterised by higher or lower concentrations of certain chemicals in the soil, and which influence the nature of the biocycles in these regions. This inter-relationship between soils and living organisms forms a branch of ecology which is termed geochemical ecology.

While much has been written about trace element deficiencies, there appear to be no references to plants growing in undisturbed natural communities showing any visual signs of deficiency. Deficiencies may occur in natural communities, if they are disturbed, and Schütte⁴ cites the case of nutritional deficiency symptoms in cocoa trees in the Amazonian forests, when the higher canopy of the forest trees is broken to let in light; but as natural communities are adapted to their environment, deficiency symptoms are not likely to be found. When vegetation shows deficiency symptoms, then it is suffering from an acute shortage of some essential nutrient and it is doubtful whether that vegetation would survive for long under natural conditions.

OBSERVATIONS

Acute trace element deficiency in vegetation was observed in the Muizenberg mountains and in Bains Kloof, Cape. The former region was investigated in some detail.

The undisturbed vegetation in which the deficiencies occurred, was typical Cape Protea bush of the open kind, as described by Adamson⁵ as occurring on sandstone. The most acute deficiencies were found on the steep side of Muizenberg Mountain above St. James at an altitude of 5—600 feet above sea level. The soil was derived from Table Mountain sandstone. It was very sandy, had no structure and was virtually devoid of organic matter and of clay. It was excessively leached and had a pH of 6·7. In spite of the poverty of the soil, the vegetation cover was good, but many of the plants carried foliage that was chlorotic (Plate I). Throughout this vegetation were scattered plants with distinct deficiency symptoms (Plate II).

While there were identifiable deficiencies in the following plants: *Alciope tabularis*, *Senecio rigidus*, *Rhus tomentosa*, *Hermas villosa*, *Cassine capensis* and *Lobostemon glaucophyllus*, and possible deficiencies in *Olea* and some *Pelargonium* species, this does not mean that the rest of the vegetation, especially the proteaceous and ericoid constituents, were normal. With our present knowledge, it is not possible to recognise deficiencies in these genera, so that deficiencies in them may not have been recognised.

Table I shows the deficiencies that were established by visual diagnosis.

TABLE I

	Plant	Deficiency
(i)	<i>Alciope tabularis</i>	Manganese
(ii)	<i>Senecio rigidus</i>	Manganese
(iii)	<i>Rhus tomentosa</i> L.	Zinc, manganese and magnesium
(iv)	<i>Hermas villosa</i>	Manganese and magnesium
(v)	<i>Cassine capensis</i>	Manganese
(vi)	<i>Lobostemon glaucophyllus</i>	Zinc

Diagnosis of visual deficiencies can be very misleading, so they were checked by foliar application of trace element solutions. As these plants have thick cuticular coverings, the leaves were pricked with needles before application of the solutions to ensure that they entered the leaves. When the element that is deficient has been supplied, there is a recovery from chlorosis in about ten days, and the improved colour can readily be observed. This technique confirmed the visual diagnosis and also established that copper deficiency, which had not been suspected, was also present.



PLATE I.—This photograph shows the good vegetation cover in the Muizenberg Mountains where deficiencies were observed. The coarse leached out nature of the soil can be clearly seen.



PLATE II.—*Rhus tomentosa* plants in situ, showing acute and characteristic deficiency symptoms on the leaves. Interveneal chlorosis of manganese deficiency is visible on a number of leaves, while the acute marginal chlorosis is of mixed origin, probably copper, manganese and magnesium deficiency.



PLATE III.—*Hermas villosa* exhibiting manganese deficiency symptoms.



PLATE IV.—Photograph to show the clear cut difference between a manganese deficient leaf of *Hermas villosa* (left) and a normal leaf of the same plant (right).



PLATE V.—*Rhus tomentosa* showing zinc deficiency (right). Note smaller more pointed leaves ("little leaf") and the bunched arrangement of the leaves ("rosette"), in contrast to the large broad and deep green leaves of the control (left) which are evenly distributed on the branch.

The deficiencies that were observed in Bains Kloof (altitude 3,000 ft.) were not checked in this way but there large plants of *Olea exasperata* showed clear-cut symptoms of manganese deficiency and some zinc deficiency; *Heeria argentea* showed acute zinc deficiency, while the small ephemeral *Oxalis purpurea* showed severe manganese deficiencies.

Deficiencies of this sort do not appear to have been observed before. It is quite possible that these deficiencies are unduly widespread this year (1958) owing to the very heavy rainfall early in the year which may have caused severe leaching. These deficient plants grew in very light sandy soils, on very steep slopes. The rate of water run-off and of leaching was very rapid. During rain storms, the water draining off the slopes of Muizenberg Mountain that had deficient plants growing on them, was perfectly clear and contained no clay or other colloidal matter. In fact, the soil colloids had been leached out of the soil. In other parts of the mountain, where the vegetation was normal and healthy, the drainage water was muddy, showing that the soils still contained sufficient quantities of leachable matter in them for clay and colloids to be washed out during periods of heavy rain.

DISCUSSION

The importance of these observations is twofold. Firstly, this is the first occasion on which acute deficiencies in natural vegetation has been observed. Previously, these deficiencies had been observed in cultivated plants, which were not completely adapted to their environment. In South Africa, soils tend to be poor in trace elements and 80 per cent of agricultural land carries crops that suffer from some form of nutritional disturbance, especially deficiencies⁶; but the naturally occurring vegetation is usually assumed to be adapted to its environment and Rademacher² has shown that the moor vegetation of the copper deficient North German Plain with such characteristic plants as birch (*Betula verrucosa* Erhart) has a very low copper requirement and so thrives in this region.

A vegetation that is not adapted to its environment must give place to one that is more adapted to these special conditions, and hence more successful. Thus a vegetation that suffers from nutritional deficiencies on certain soil types, is likely to be replaced by more adapted plants whose nutritional requirements are met by these soils.

The second important aspect of these deficiencies is that they may throw some light onto the changes that are taking place in the Cape vegetation at the present time. The native vegetation of this region is rapidly being reduced, and in some areas there is real danger that it will

be eliminated. To combat this danger, veld reserves are being established in many areas.

The native vegetation has been cleared, in many cases, for agricultural development. Forests and shrubs have been cut down and fires, both deliberate and accidental, ravage the remnants of the native vegetation. This clearing and burning has resulted in a marked impoverishment of the soil. Burchell⁷ and the early travellers make it quite clear that the vegetation in the Western Cape was quite dense, and that even on the Karoo the soils were covered by a low mat of vegetation. In many areas conditions were very much less arid and eroded thirty years ago, and the remnants of the older state of affairs were fairly common. Within the last three decades conditions have changed very considerably. In other words, the natural habitat for the Cape vegetation is not the oft burned and eroded mountain slopes of to-day, but a well covered, reasonably rich soil. That the larger constituents of this flora, such as *Proteas*, flourish on good soils is well known, and there appears to be no reason to assume that the Cape flora is in any way especially adapted to nutritionally poor substrates.

Besides agricultural practices, the other serious threat to the natural vegetation is the rate at which certain exotic plants are spreading, and completely subjugating the local floras. In the neighbourhood of the Cape Peninsula the most important exotics are undoubtedly three species of *Acacia*—*A. cyclops*, *A. longifolia* and *A. cyanophylla*—two species of *Hakea*—*H. gibbosa* and *H. acicularis* and *Pinus pinaster*. All these, except *P. pinaster*, come from areas in Australia where trace element deficiencies are widespread, while *P. pinaster* comes from eroded mountainous regions in the Mediterranean. There is every reason to believe that these exotics, which are spreading so rapidly in the Western Province, are in fact members of adapted floras; floras which can survive and flourish upon nutritionally deficient soils on which unadapted plants can at best barely survive.

Their rapid spread and the successful competition which they offer to the local vegetation, shows that these rapidly spreading exotics are in fact more suited to present day conditions in the Cape. The old flora, which must have developed under conditions of better ground coverage and nutritionally more balanced soils, is not suited to successful colonisation of bare and impoverished soils, and conditions are definitely marginal for it. The occurrence of trace element deficiencies makes this quite clear. Unless nutritional, and other factors, can be adjusted in such a way as to supply the requirements of the native vegetation, it must recede and be replaced by the more adapted exotics that are at present so rapidly replacing it.

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